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मानक

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“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 12313 (1988): Hot-dip Terne Coated Carbon Steel Sheets
[MTD 4: Wrought Steel Products]



“ज्ञान से एक नये भारत का निर्माण”

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

**SPECIFICATION FOR
HOT-DIP TERNE COATED CARBON STEEL SHEETS**

Wrought Steel Products Sectional Committee, SMDC 5; Steel Sheets Subcommittee, SMDC 5; 3 [Ref : Doc : SMDC 5 (2024)]

1. Scope — Covers the requirements of terne coated carbon steel sheets of thicknesses from 0.3 to 2.0 mm for use in automobile industry, and as a roofing material and similar other applications.

2. Definitions and Other Information — For the purpose of this standard, the following definition shall apply.

2.1 Continuous Hot-Dip Terne (Lead Alloy) Coated Cold-Reduced Steel Sheet — A product obtained by hot-dip coating cold-reduced sheet coils on a continuous lead alloy coating line to produce either lead alloy coated coils or lead alloy coated cut lengths.

2.2 Terne (Lead Alloy) — In the context of this Standard, any lead-based alloy in commercial use for the hot-dip coating of steel sheet. Tin is the most common alloying element, but antimony is also commercially used, are combinations of both elements. If a specific alloy composition is required, it shall be by agreement between the manufacturer and the purchaser.

2.3 Designation System — Terne Coating and Qualities — The produced hot-dip terne coating is designated T0 (the '0' is inserted to fill a computer space and has no significance in the designation) as shown in Table 1. The coating mass designation follows the T0 and three spaces are allocated for coating mass designation. If only two spaces are required, such as for designation '75', then the '75' is preceded by a '0' to fill computer space and is shown as '075'. If the product is skin passed, designation 'S' is used to indicate the coating condition. If the product has not been skin passed, the designation 'N' for normal coating (as produced) is shown. The numbers 01, 02, 03 and 04 are common to other standards indicating the qualities of commercial, drawing, deep drawing, and deep drawing special killed. An example of a complete condition designation including coating, coating mass, coating condition and quality is T0 120N01. This is composed by combining the following:

T0 = terne coating

120 = coating designation (see Table 2)

N = normal coating

01 = ordinary quality

2.4 Skin Pass — A light cold rolling of terne sheet. The purposes of skin passing are one or more of the following:

- a) To minimize temporarily the occurrence of conditions known as stretcher strain (Luder's lines) or fluting during fabrication of finished parts.
- b) To control shape.
- c) To produce a higher degree of surface smoothness and to improve appearance or suitability for decorative painting. This process may adversely affect the ductility of the base metal.

2.5 Strain Ageing — Terne sheet (except T0 04) tends to strain age. Grade T0 04 should be specified where strain ageing is not acceptable and where roller levelling is not possible.

2.6 Oiling — Terne sheet is produced either oiled or not oiled, and is usually not degreased.

Adopted 25 February 1988

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Gr 7

**BUREAU OF INDIAN STANDARDS
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3. Conditions of Manufacture

3.1 Steelmaking — The process used in making steel and in manufacturing terne sheet should be agreed between the manufacturer and the purchaser.

3.2 Ladle Analysis — The ladle analysis of steel, when carried out either by the method specified in relevant parts of IS : 228 'Methods for chemical analysis of steel (*second revision*)' (issued in parts) or any other established instrumental/chemical method, shall be as given in Table 1. In case of any dispute, the procedure given in relevant parts of IS : 228 shall be the referee method.

TABLE 1 CHEMICAL COMPOSITION (LADLE ANALYSIS)

Quality		C	Mn	P	S
Designation	Name	Max	Max	Max	Max
T0 01	Ordinary	0.15	0.60	0.055	0.055
T0 02	Drawing	0.12	0.50	0.04	0.04
T0 03	Deep drawing	0.10	0.45	0.03	0.03
T0 04	Deep drawing special killed	0.08	0.45	0.03	0.03

3.3 Product Analysis — Permissible variation in the case of product analysis from the limits specified in Table 1 shall be given as below:

Constituent	Permissible Variation Over Specified Limit, Percent
Carbon	0.02
Manganese	0.03
Sulphur	0.005
Phosphorus	0.005

Note 1 — The requirements regarding permissible variation on product analysis shall not apply to rimming steels.

Note 2 — When the steel is killed with aluminium, the total soluble aluminium in steel shall be between 0.02 and 0.6 percent, which shall be ensured by the manufacturer by occasional checks.

Note 3 — When the steel is rimming or semi-killed or is not fully killed by aluminium alone, nitrogen content shall not exceed 0.007 percent. This should be ensured by occasional check analysis.

Note 4 — When the steel is silicon killed, the silicon content on analysis shall not be less than 0.1 percent. When the steel is silicon-aluminium or aluminium killed, the requirement regarding minimum silicon content shall not apply.

Note 5 — The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20 and 0.35 percent on analysis. On product analysis, this shall be between 0.17 and 0.38 percent.

3.4 Terne (Lead Alloy) Coating Mass — The mass of coating shall conform to the requirements in Table 2 for the specific coating designation. The mass of coating is the total amount on both surfaces of the sheet, expressed in grams per square metre (g/m^2) of sheet. Methods of checking that the material complies with this standard are given in 5.2, 6.2 and Appendix A. Procedures other than those covered in Appendix A may be permitted upon agreement by the manufacturer and the purchaser.

TABLE 2 COATING DESIGNATIONS AND LIMITS

Coating Designation	Minimum Coating Mass Limits, g/m^2 (Total Both Sides)	
	Triple Spot Test Check Limits	Single Spot Test Check Limits
001	no minimum	no minimum
050	50	40
075	75	60
100	100	75
120	120	90

Note — ' no minimum ' means that there are no established minimum check limits for triple spot and single spot tests.

AMENDMENT NO. 1 APRIL 2002
TO
IS 12313 : 1988 SPECIFICATION FOR HOT-DIP TERNE
COATED CARBON STEEL SHEETS

(*Page 1, clause 1*) — Substitute the following for the existing:

'1. Scope — This standard covers the requirements of terne coated carbon steel sheets for use in automobile industry, as a roofing material and other similar applications. The thickness of the sheet shall be between 0.3 to 2.0 mm. The thickness other than this may be as agreed to between the purchaser and the manufacturer.'

(MTD 4)

Reprography Unit, BIS, New Delhi, India

3.5 Application — It is desirable that terne sheet be identified for fabrication by name of the part or by the intended application. Terne sheet of drawing qualities (T0 02, T0 03 and T0 04) may be produced to make an identified part within a properly established breakage allowance, which shall be previously agreed upon between the producer and the purchaser. In this case, the part name, the details of fabrication and special requirements (that is, exposed or unexposed, freedom from stretcher strains or fluting, coating performance requirements) shall be specified and the mechanical properties given in Table 3 shall not apply.

3.6 Mechanical Properties — Except when ordered to an identified part as explained in 3.5 at the time that the steel is made available for shipment, the mechanical properties shall be as stated in Table 3 when they are determined on test pieces obtained according to the requirements of 6.1.

Note — Prolonged storage of the sheet after skin passing can cause a change in mechanical properties and increase in drawability. To minimize this effect, quality T0704 should be specified.

TABLE 3 MECHANICAL PROPERTIES

Quality		Tensile Strength R_m Max* MPa (N/mm ²)	Percentage Elongation		180° Bend Mandrel Diameter, for All Thickness
Designation	Name		A Min†		
			Gauge length	Gauge length	
			$l_0 = 60$ mm	$l_0 = 80$ mm	
T0 01	Ordinary	—	—	—	1a
T0 02	Drawing	430	24	23	—
T0 03	Deep drawing	410	28	25	—
T0 04	Deep drawing special killed	410	29	28	—

a = thickness of bend test piece.

*Minimum tensile strength for qualities T0 02, T0 03 and T0 04 would normally be expected to be 260 MPa. All tensile strength values are determined to the nearest 10 MPa.

†For material up to and including 0.6 mm in thickness, the elongation values in the table shall be reduced by 2. For thickness up to 2 mm, use either $l_0 = 50$ mm or $l_0 = 80$ mm.

4. Dimensional Tolerances — Tolerance limits for terne sheet are shown in Tables 5 to 13.

5. Sampling

5.1 Mechanical Tests

5.1.1 Tensile test — When ordered to mechanical properties, one representative sample for the tensile property test required in Table 3 shall be taken from each lot of shipment. A lot consists of 50 tonnes or less of sheet of the same quality rolled to the same thickness and condition.

5.1.2 Bend test — One representative sample for the bend test (applicable only to quality T0 01) shall be taken from each lot (see 5.1.1) of sheet for shipment.

5.2 Coating Tests

5.2.1 Mass of coating — The producer shall make such tests and measurements as he deems necessary to ensure that the material produced complies with the values in Table 2. The purchaser may verify the mass of coating by the following sampling method.

Three specimens shall be cut, one from the mid width position, and one from each side not closer than 25 mm from the side edge. The minimum specimen area should be 2 000 mm².

5.2.2 Bend test — One representative sample shall be taken from each lot of sheet for shipment. The specimens should be taken for the coated bend test, not closer than 25 mm from the side edge. The minimum specimen width should be 50 mm.

6. Test Methods

6.1 Mechanical Tests

6.1.1 Tensile test (base metal) — The tensile test shall be performed in accordance with IS: 1663-1972 'Method for tensile testing of steel sheet and strip of thickness 0.5 mm to 3 mm (first revision)'. Transverse or longitudinal test pieces shall be taken mid way between the centre and edge of the sheet as rolled. Since the tensile test is for determination of properties of the base metal, ends of test pieces should be stripped of the coating to measure base metal thickness for calculation of cross sectional area.

6.1.2 Bend test (base metal) (applicable only to quality T0 01) — The transverse bend test piece, stripped of coating in a suitably inhibited acid, shall withstand being bent through 180° in the direction shown in Fig. 1, around the inside diameter as shown in Table 3 without cracking on the outside of the bent portion. The bend test shall be performed at ambient temperature and as described in IS : 1599-1985 'Method for bend test (second revision)'.

6.2 Coating Tests

6.2.1 Triple spot test — The triple spot test result is the average coating mass found on the three pieces taken according to 5.2.1. The test is normally carried out by stamping out a known area of sheet and calculating the coating mass from the loss in mass after removing the terne (lead alloy) coating in suitably inhibited acid (see Appendix A for suggested methods). Procedures other than those in Appendix A may be permitted upon agreement by the manufacturer and the purchaser.

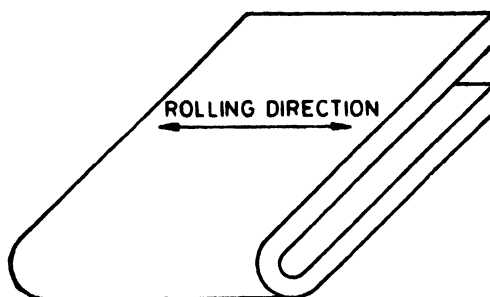


FIG. 1 TRANSVERSE BEND TEST PIECE (After Bending)

6.2.2 Single spot test — The single spot test result shall be the minimum coating mass found on any one of the three specimens used for the triple spot test. Material slit from wide coil will be subject to a single spot test.

6.2.3 Bend test (coating) — Bend test pieces taken after coating (before additional processing) shall withstand being bent through 180° in either direction without flaking of the coating on the outside of the bend. The radius of the bend is determined by the number of pieces of the same thickness (or mandrel equivalent) as shown in Table 4. Flaking of coating within 7 mm from the edge of the specimen shall not be cause for rejection.

TABLE 4 COATING BEND TEST REQUIREMENTS

180°C Bend Mandrel Diameter, for All Thicknesses and All Coating Designations

Ordinary Quality	Drawing Qualities
1a	O (flat on itself)

a — thickness of bend test piece

TABLE 5 THICKNESS TOLERANCES FOR COILS* AND CUT LENGTHS

(Clause 4)

All dimensions in millimetres.

Specified Widths	Thickness Tolerances† Over and Under, for Specified Thickness					
	Up to 0.4	Above 0.4	Above 0.6	Above 0.8	Above 1.0	Above 1.2
		Up to 0.6	Up to 0.8	Up to 1.0	Up to 1.2	Up to 1.6
Up to 1 200	0.07	0.08	0.09	0.10	0.12	0.14
Over 1 200	0.08	0.09	0.10	0.11	0.13	0.15

*The thickness tolerances for sheet in coil form are the same as for sheets supplied in cut lengths but in cases where welds are present, the tolerances should be double those given over a length of 15 m in the vicinity of the weld.

†Thickness is measured at any point on the sheet not less than 40 mm from a side edge.

TABLE 6 WIDTH TOLERANCES FOR COILS AND CUT LENGTHS, NOT RESQUARED

(Clause 4)

All dimensions in millimetres.

Specified Widths	Tolerance
Up to 1 200	+ 5 - 0
Above 1 200	+ 7 - 0

TABLE 7 LENGTH TOLERANCES FOR CUT LENGTHS, NOT RESQUARED

(Clause 4)

All dimensions in millimetres.

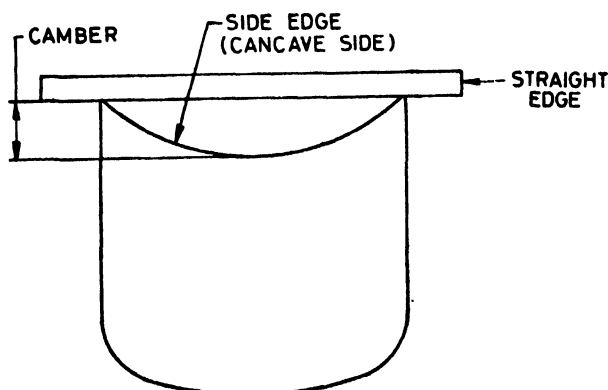
Specified Lengths	Tolerance
Up to 3 000	+ 20 - 0
Above 3 000 up to 6 000	+ 30 - 0
Above 6 000	+ 0.5 percent - 0

TABLE 8 CAMBER* TOLERANCES

(Clause 4)

Form	Camber Tolerance
Cut lengths	0.4 percent $\times$ length
Coils	20 mm in any 5 000 mm length

*Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge.

**FIG. 2 MEASUREMENT OF CAMBER****TABLE 9 *OUT OF SQUARE TOLERANCES FOR CUT LENGTHS, NOT RESQUARED**

(Clause 4)

Dimensions	*Out-of-Square Tolerance
All thicknesses and all sizes	1.0% $\times$ width

*Out-of-square is the greatest deviation of an edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in Fig. 3. It can also be measured as one-half the difference between the diagonals of cut length sheet.

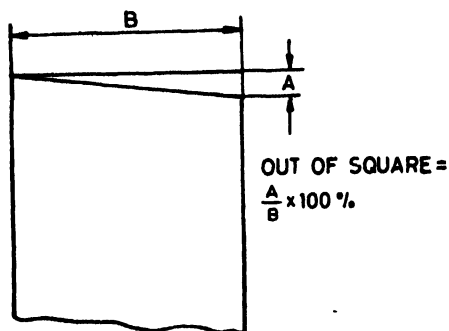


FIG. 3 MEASUREMENT OF OUT-OF-SQUARE

TABLE 10 OUT-OF-SQUARE* TOLERANCES FOR RESQUARED† MATERIAL
 (Clause 4)

All dimensions in millimetres.

Specified Lengths	Specified Widths	Out-of- Square Tolerance
Up to 3 000	Up to 1 200	+ 2 - 0
	Above 1 200	+ 3 - 0
Above 3 000	All widths	+ 3 - 0

*See Fig. 3.

†When measuring material ordered to resquared tolerances, consideration may have to be given to extreme variations in temperature.

TABLE 11 STANDARD FLATNESS TOLERANCES* FOR CUT LENGTHS

(Clause 4)

All dimensions in millimetres.

Specified Thickness	Specified Widths	Flatness Tolerances†
Up to 0.7	Up to 1 200	15
	Above 1 200	18
Above 0.7 up to 1.2	Up to 1 200	12
	Above 1 200	15
Above 1.2	Up to 1 200	10
	Above 1 200	12

*These tolerances are only applicable to sheet up to 5 000 mm length when their thickness is 1.6 mm or less. The flatness tolerance for sheets over 1.6 mm in thickness should be mutually agreed upon. This table also applies to sheet cut to length from coil by the purchaser when adequate flattening procedures are performed. Tolerances for sheet exceeding 5 000 mm in length are subject to agreement.

†Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness.

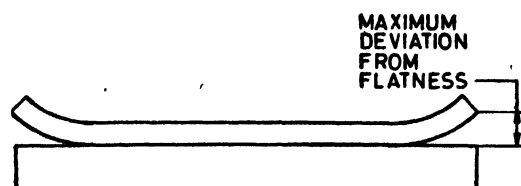


FIG. 4 MEASUREMENT OF FLATNESS

TABLE 12 SPECIAL FLATNESS TOLERANCES* FOR CUT LENGTH ROLLER-LEVELLED OR STRETCHER-LEVELLED

(Clause 4)

All dimensions in millimetres.

Specified Thickness	Specified Widths	Flatness Tolerances†
Up to 0.7	Up to 1 200	6
	Above 1 200	7
Above 0.7 Up to 1.2	Up to 1 200	5
	Above 1 200	6
Above 1.2	Up to 1 200	4
	Above 1 200	5

*Tolerance for sheet exceeding 5 000 mm in length are subject to agreement.

†Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness (see Fig. 4).

TABLE 13 WIDTH AND LENGTH ALLOWANCES* FOR MATERIAL WITH STRETCHER-LEVELLED STANDARD OF FLATNESS

(Clause 4)

All dimensions in millimetres.

Specified Lengths	Allowances Over Specified Dimensions		
	Width	Grip or entry marks outside specified length	Grip or entry marks inside specified length
Up to 3 000	19	100	75
Above 3 000 to 4 000	25	100	75
Above 4 000	32	125	100

Note — When terne sheet is specified to stretcher-levelled standard of flatness and not resquared, the allowances over specified dimensions in width and length given in the table apply. Under these conditions, the allowances for width and length are added by the manufacturer to the specified width and length and the tolerances given in Tables 6 and 7 apply on the basis of the new size established. The camber tolerances in Table 8 do not apply.

When sheet is not to have grip or entry marks within the specified length, the purchaser shall specify 'grip or entry marks outside specified length'. When sheet may have grip or entry marks within the specified length, purchaser shall specify 'grip or entry marks inside specified length'.

*Allowances for sheet exceeding 5 000 mm in length are subject to agreement.

7. Retests — If a test does not give the required results, two more tests shall be carried out at a random on the same lot. Both retests must conform to the requirements of this standard, otherwise the lot may be rejected.

8. Workmanship — The terne sheet in cut lengths shall be free from amounts of laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing. Processing for shipment in coils does not afford the producer the opportunity to observe readily or to remove defective portions as can be carried out on the cut length product. An excessive number of defects may be the cause of rejection.

9. Inspection and Acceptance

9.1 While not usually required for products covered by this standard, when the purchaser specifies that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works, the manufacturer shall provide the purchaser's inspector all reasonable facilities to determine that the sheet is being furnished in accordance with this standard.

9.2 Terne sheet that is reported to be defective after arrival at the user's works shall be set aside properly and correctly identified and adequately protected. The supplier shall be notified in order that he may properly investigate.

10. Coil Size — When terne sheet is ordered in coils, a minimum or range of acceptable inside diameter (I.D.) shall be specified. In addition, the maximum outside diameter (O.D.) and maximum acceptable coil mass shall be specified.

11. Marking — Unless otherwise stated, the following minimum requirements for identifying the terne sheet shall be legibly stenciled on the top of each lift or shown on a tag attached to each coil or shipping unit:

- a) Manufacturer's name or trade-mark,
- b) Quality designation,
- c) Coating designation,
- d) Product dimensions,
- e) Lot number, and
- f) Mass.

11.1 Standard Marking — Details available with the Bureau of Indian Standards.

12. Information to be Supplied by the Purchaser

12.1 To specify adequately the requirements under this Standard, inquiries and orders shall include the following information:

- a) Number of this standard;
- b) Name, coating designation, coating condition and quality of material [for example, terne sheet (T0 120 N0 2) see 2.3];
- c) Dimensions of product (the thickness includes the coating) and quantity required;
- d) Application (name of part or intended usage), if possible (see 3.5);
- e) For drawing qualities T0 02, T0 03, T0 04, whether ordered to mechanical properties (see 3.6) or to fabricate on identified part (see 3.5);
- f) Oiled, if required (see 2.6);
- g) Coil size requirements (see 10);
- h) Report of cast analysis, if required;
- j) Details of fabrication or special requirements (fluting or coating performance); and
- k) Inspection and tests for acceptance prior to shipment from the producer's works, if required (see 9.1).

Note — A typical ordering description is as follows:

IS : 12313 ternesheet, T0 100 N02, drawing quality, dimensions 0.46 × 1 200 × 2 400 mm, 20 000 kg, to fabricate drawn fuel tanks.

APPENDIX A

(Clauses 3.4 and 6.2.1)

DETERMINATION OF MASS AND COMPOSITION OF COATING ON TERNE (LEAD ALLOY) COATED SHEET

A-1. General

A-1.1 This appendix covers the determination of the mass and composition of coating onterne sheets by the triple spot method. Five procedures are described as follows:

- a) Procedure A : Stripping with sulphuric acid,
- b) Procedure B : Electrolytic stripping,
- c) Procedure C : Stripping with silver nitrate solution,
- d) Procedure D : Stripping with hydrochloric acid and antimony (III) chloride, and
- e) Procedure E : Stripping with sodium hydroxide and sodium peroxide.

A-1.2 If the percentage of tin or lead or both in the coating is required, stripping with sulphuric acid is the preferred procedure. Electrolytic stripping and stripping with silver nitrate or antimony (III) chloride or sodium hydroxide and sodium peroxide are convenient procedures where a large number of determinations of mass of coating are to be made.

A-2. Test Specimens

A-2.1 Test specimens shall be stamped or cut from the sheet, usually from the centre and near both edges.

A-2.2 Specimens shall be 50 ± 0.25 mm square 56.42 ± 0.25 mm in diameter except that for material narrower than 50 mm in width, test specimens shall be of such a length that the area of the specimen is equal to 2 500 mm². The mass of coating in grams on a specimen 50 mm square (2 500 mm² in area) when multiplied by 400 is equal to the mass of coating in grams per square metre of sheet. When it is not possible to secure a specimen of 2 500 mm² in area, a smaller size may be used, but it is recommended that a specimen of not less than 2 000 mm² be used.

A-2.3 The specimens shall be clean, if necessary, they shall be washed with solvent naphtha or other suitable solvent, then with alcohol and dried thoroughly.

A-3. Procedure A — Stripping with Sulphuric Acid

A-3.1 Reagents — Reagent grade chemicals shall be used in all tests. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

A-3.1.1 Cerium (IV) sulphate — Standard volumetric solution (1 ml $\triangleq$ 0.005 6 g Fe, 0.1 N). Prepare and standardize so that the solution will be 0.1 N.

A-3.1.2 Erioglaucine Indicator — Prepare a 0.1 percent (m/m) solution of erioglaucine A in water.

A-3.1.3 Hydrochloric acid, p 1.12 g/ml — Mix 500 ml of cp or reagent grade hydrochloric acid (p 1.19 g/ml) with 400 ml of distilled water.

A-3.1.4 Mercury (II) chloride solution (50 g/l) — Dissolve 50 g of mercury (II) chloride (HgCl₂) in water and dilute to 1 litre.

A-3.1.5 Potassium iodate — Standard volumetric solution (1 ml $\triangleq$ 0.003 g Sn, 0.05N). Prepare and standardize so that the solution will be 0.05 N.

A-3.1.6 Potassium permanganate saturated solution

A-3.1.7 Sodium hydrogen carbonate, saturated solution — Saturate freshly boiled distilled water with sodium hydrogen carbonate (NaHCO₃).

A-3.1.8 Sodium hydrogen carbonate 1 percent (w/v) — Dissolve about 10 g of sodium hydrogen carbonate (NaHCO₃) in 1 litre of freshly boiled distilled water.

A-3.1.9 Tin (II) chloride solution — Dissolve 150 g of tin (II) chloride dihydrate (SnCl₂·2H₂O) in 1 litre of hydrochloric acid, diluted 1+2 (V+V).

A-3.1.10 Starch solution

A-3.1.11 Sulphuric acid — p 1.84 g/ml, cp or reagent grade.

A-3.2 Procedure for Stripping — Accurately determine the mass of each test specimen in grams. Wrap a stiff platinum or nickel wire about each specimen in such a manner that it may be held firmly in an acid solution in a horizontal position. Using a 400-ml beaker, heat 60 ml of the sulphuric acid (A-3.1.11) to 250°C (see Caution). Immerse each specimen for about 1 min in the hot acid; then remove and momentarily immerse in 50 ml of distilled water contained in a 600 ml beaker. Rub the surface of the specimen with a rubber tipped glass rod while washing with about 50 ml of distilled water from a wash bottle. If the coating has not been completely removed, again immerse in the acid and repeat the procedure. Thoroughly dry and reweigh the specimen. The loss in mass, Δm , represents the mass of coating, together with some iron dissolved from the steel sheet.

CAUTION — A suitable face shield should be worn in order to protect the operator from accidental splashing or popping of hot sulphuric acid.

A-3.3 Chemical Analysis

A-3.3.1 Test solution — Cool the sulphuric acid solution in which the specimen was stripped and combine with the washings obtained in the 600-ml beaker while stripping the specimen. Pour the solution into a 500-ml volumetric flask and rinse the beaker with hydrochloric acid (A-3.1.3). Add the rinsing to the flask and dilute to the 500 ml mark with hydrochloric acid (A-3.1.3), again diluting to the mark after cooling, if necessary. The solution may now be analysed for iron and, if desired, lead and tin.

A-3.3.2 Determination of iron — Transfer 100 ml aliquot of the solution in the 500-ml volumetric flask (see A-3.3.1) to a 600-ml beaker. Add 1 to 2 ml of the saturated potassium permanganate solution (A-3.1.6) to oxidize iron and tin, and heat to boiling. Cool and add slight excess of ammonia. Filter and wash the precipitate with hot water. Dissolve the precipitate in the original beaker with hydrochloric acid (A-3.1.3) and hot water. Evaporate the solution to a volume of about 10 ml and reduce with the tin (II) chloride solution (A-3.1.9). Add 10 ml of the mercury (II) chloride solution (A-3.1.4) and 400 ml of water. Titrate with the standard volumetric cerium (IV) sulphate solution (A-3.1.1) using erioglaucine (A-3.1.2) as indicator. Calculate the mass, m_{Fe} in grams of iron dissolved from the test specimen using the formula:

$$m_{Fe} = 5m_1V_1$$

where

V_1 = volume in millilitres of the standard volumetric cerium (IV) sulphate solution required for the titration, and

m_1 = mass in grams of iron equivalent to 1 ml of the standard volumetric cerium (IV) sulphate solution.

A-3.3.3 Determination of tin — Transfer 200 ml aliquot of the test solution (see A-3.3.1) to a 300-ml Erlenmeyer flask. Add 3 g of iron in the form of fine wire or thin sheet and 1 g of powdered antimony. Fit the flask with a one-hole rubber stopper containing a glass tube bent twice at right angles, with the end of the short bend projecting through the stopper, the other end being long enough to reach almost to the bottom of a beaker placed on a level with the flask. Pour about 300 ml of the dilute sodium hydrogen carbonate solution (A-3.1.8) into that beaker. Place the flask on a hot-plate, with the glass tube extending into the beaker. After boiling the solution in the flask for about 5 min, remove the beaker containing the dilute sodium hydrogen carbonate solution and substitute by another beaker containing about 50 ml of the saturated sodium hydrogen carbonate solution (A-3.1.7). Move both, the beaker and the flask, to a cool place. This will cause a small amount of the saturated sodium hydrogen carbonate solution to enter the flask and exclude the air. Finally cool the solution in the flask to about 8-10°C. Add several millilitres of the starch solution (A-3.1.10) and titrate with the standard potassium iodate solution (A-3.1.5). It is desirable to run a duplicate analysis for tin adding the standard potassium iodate solution quickly to a point slightly less than the end point obtained in the previous determination. Then finish the titration more slowly. This duplicate analysis may be run using one or the other test specimens. Calculate the mass m_{Sn} in grams, of tin stripped from the test specimen using the formula:

$$m_{Sn} = \frac{5 m_2 V_2}{2}$$

where

V_s = volume in millilitres of the standard volumetric potassium iodate solution required for the titration, and

m_s = mass, in grams, of tin equivalent to 1 ml of the standard volumetric potassium iodate solution.

A-3.3.4 Determination of lead — After ascertaining that all the lead (II) chloride is in the solution, remove a 100 ml aliquot from the 500 ml volumetric flask (see A-3.3.1) and place in a 400 ml beaker. Add 10 ml of the sulphuric acid (A-3.1.11), cover and evaporate to fumes of sulphur trioxide. Cool and dilute to 200 ml with water. Allow to settle and then filter on weighed Gooch crucible, washing with sulphuric acid, diluted 1 + 19 (V + V). Dry and ignite at a dull red heat. Cool and reweigh. Calculate the mass, m_{pb} in grams, of lead stripped from the test specimen using the formula:

$$m_{pb} = 5 (m_s - m_t) \times 0.6831$$

where

m_s = mass, in grams, of the Gooch crucible and ignited precipitate, and

m_t = mass, in grams, of the Gooch crucible.

A-3.4 Calculations

A-3.4.1 Mass of coating

Calculate the mass of coating in grams per square metre using the formula:

$$400 (\Delta m - m_{te})$$

where

Δm = loss in mass, in grams, from the specimen (see A-3.2.1); and

m_{te} = mass in grams of iron dissolved from the test specimen (see A-3.3.2) where a specimen of 2 500 mm² in area is used. For specimens of other sizes, a suitable correction factor shall be applied.

A-3.4.2 Percentage of tin in coating — Calculate the percentage, by mass, of tin in the coating using the formula:

$$\frac{m_{sn}}{m_{sn} + m_{pb}} \times 100$$

where

m_{sn} = mass, in grams, of tin stripped from the test specimen (see A-3.3.3); and

m_{pb} = mass, in grams, of lead stripped from the test specimen (see A-3.3.4).

A-3.4.3 Percentage of lead in coating — Calculate the percentage of lead in the coating by subtracting the percentage of tin (see A-3.4.2) from 100 percent.

A-4. Procedure B — Electrolytic Stripping

A-4.1 Reagents

A-4.1.1 Hydrochloric acid — diluted 1 + 3 (V + V) — Mix 1 part of cp or reagent grade hydrochloric acid (p 1.19 g/ml) with 3 parts of water.

A-4.1.2 Sodium hydroxide solution — Dissolve 100 g of sodium hydroxide (NaOH) in distilled water and dilute to 1 litre.

A-4.2 Procedure for stripping — After cleaning the test specimens as described in A-2.3 weigh each specimen separately. Strip anodically in the sodium hydroxide solution (A-4.1.2) at a temperature of 77 to 80°C for 10 to 12 min, or until the coating is completely removed, using a current of 4 A. Reverse the current for 6 to 15 s and then turn it off. Remove the test specimens and wash with water. Dip in hydrochloric acid (A-4.1.1) for 1 to 2 s and rinse again. Dry and reweigh the specimens separately.

Note — The test specimens may be conveniently supported vertically by their bottom edges with two hook-shaped pieces of copper wire fastened to a copper bar laid across a 2-litre beaker containing the stripping solution, which may be used for a number of specimens. The cathodes, consisting of two pieces of sheet lead, may be supported on each side of the test specimen by the edge of the beaker. A 6 V automobile battery of a low voltage rectifier are suitable sources of current, a series resistance being utilized for adjusting the current to 4 A.

A-4.3 Calculation — The loss in mass in grams multiplied by 400 is equal to the coating mass in grams per square metre of sheet when a specimen of 2 500 mm² in area is used. For specimens of other sizes, a suitable correction factor shall be applied.

A-5. Procedure C — Stripping with Silver Nitrate Solution

A-5.1 Reagent

A-5.1.1 Silver nitrate solution — Dissolve 200 g of silver nitrate (AgNO₃) in distilled water and dilute to 1 litre.

A-5.2 Procedure for Stripping

A-5.2.1 After cleaning as described in A-2.3, weigh each test specimen separately. Then place in a beaker containing 200 ml of the silver nitrate solution (A-5.1) (see Note). Reaction is fairly rapid. The terne (lead alloy) coating goes into solution and metallic silver is deposited on the surface of the steel. Remove the silver by washing the test specimen with a stream of water from a wash bottle and rubbing with a rubber-tipped glass rod.

A-5.2.2 Examine for lead spots. If any are found, repeat the immersion until all the coating is removed. Then thoroughly wash and dry the test specimen and reweigh.

Note — The silver nitrate solution may be used repeatedly as long as lead is removed. The number of specimens that can be stripped with 200 ml of solution depends on the amount of coating on the sheets. The solution is used cold and replaced with fresh solution when the reaction becomes too slow. After the first specimen is stripped, silver nitrate solution is discoloured. Most of the silver can be recovered from the used solution and washing, if desired.

A-5.3 Calculation — The loss in mass in grams multiplied by 400 is equal to the coating mass in grams per square metre of sheet, when a specimen of 2 500 mm² in area is used. For specimens of other sizes, a suitable correction factor shall be applied.

A-6. Procedure D — Stripping with Hydrochloric Acid and Antimony (III) Chloride

A-6.1 Reagent

A-6.1.1 Antimony (III) Chloride — Hydrochloric Acid Solution — Dissolve approximately 40 g of antimony (III) chloride (SbCl₃) in cp or reagent grade hydrochloric acid (p 1.19 g/ml) and dilute to 1 litre with the hydrochloric acid.

A-6.2 Procedure for Stripping — After cleaning as described in A-2.3, weigh each test specimen separately. Immerse in the cold antimony (III) chloride-hydrochloric acid solution (A-6.1) until the coating is removed and the reaction ceases. The reaction will leave the specimen coated with antimony. Wash thoroughly to remove the loosely adherent antimony, dry and reweigh.

A-6.3 Calculation — The loss in mass in grams multiplied by 400 is the mass of coating in grams per square metre of sheet when a specimen of 2 500 mm² in area is used. For specimens of other sizes, a suitable correction factor shall be applied.

A-7. Procedure E — Stripping with Sodium Hydroxide and Sodium Peroxide

A-7.1 Reagents

A-7.1.1 Sodium hydroxide solution — 5 percent (m/m) — Dissolve 50 g of sodium hydroxide (NaOH) in 1 litre of water.

A-7.1.2 Sodium peroxide — granulated*.

A-7.2 Procedure for Stripping — After cleaning as described in A-2.3, weigh each test specimen separately. Fill a porcelain dish (approximately 120 mm in diameter) to about three-quarter capacity with sodium hydroxide solution (A-7.1.1) and heat to 60°C on a hot plate. Place the specimen in the dish making sure it is completely immersed. Slowly add the granulated sodium peroxide (A-7.1.2) until the solution becomes clear. Turn the test specimen over to expose the other side and add sodium peroxide until the solution again become clear. Stripping is complete when no more lead is detectable on the specimen. Discard the used sodium hydroxide solution. Carefully rinse the specimen with water, dry and reweigh.

A-7.3 Calculation — The loss in mass in grams multiplied by 400 is the mass of coating in grams per square metre of sheet when a specimen of 2 500 mm² in area is used. For specimens of other sizes, a suitable correction factor shall be applied.

*It is important to use only granulated sodium peroxide.

EXPLANATORY NOTE

This Standard applies to cold-rolled carbon steel sheet of the drawing qualities coated by a continuous hot-dip terne (lead alloy) coating process. It includes that group of products commonly known as terne plate or terne sheets. Terne sheets are used where ease of solderability, a degree of corrosion resistance, or amenability to stamping, pressing or deep-drawing will be advantageous. The mass of coating may be specified in accordance with Table 2. It is expressed as the total coating on both surfaces in grams per square metre. The coating mass specified should be compatible with the desired service life, thickness of the base metal and the forming requirements involved. A designation system (see 2.3) includes the coating designation, coating condition and quality.

Terne sheet is normally produced in the range of thickness 0.30 to 2.0 mm inclusive, and in widths up to 1 400 mm in coils and cut lengths. Terne sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

Ordinary quality terne sheet (T0 01) is intended for general fabricating purposes where sheet is used in the flat or for bending or moderate forming.

Drawing quality terne sheet (T0 02, T0 03 and T0 04) is intended for drawing or severe forming. It is furnished to all the requirements of this standard or with agreement, when ordered, to fabricate an identified part, in which case the mechanical properties in Table 3 do not apply. Drawing qualities are identified as follows:

T0 02 Drawing quality

T0 03 Deep drawing quality

T0 04 Extra deep drawing quality special killed

Terne sheet is suitable for welding, soldering or brazing, if appropriate methods and procedures are selected with special attention to the heavier coatings. When sheet is subjected to joining techniques involving heat, suitable precautions shall be taken to avoid toxic affects.

This standard is in agreement with the ISO 4999-1978 Hot-Dip Terne Coated Carbon Steel Sheets, issued by the International Organization for Standardization (ISO),